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(57) Abstract

The invention relates to a separating body which can be set into rotation for the purpose of separating solid or liquid particles of micron or sub-micron size from a gaseous or a liquid medium, wherein said body consists of a large number of separating ducts with singly connected walls over a part of the axial length, characterized in that the length of at least one of the ducts designated with L, the hydraulic diameter of the duct designated with d and the average axial gas speed in the duct designated with w are chosen in mutual dependence in a manner such that the dimensionless number $Lv/(wd^2)$ equals at least 0.035, preferably 0.040, wherein v is the kinematic viscosity of the gas. The invention also relates to a rotating particle separator which consists of the above described separating body onto which impellers may or may not be fixed upstream and downstream and wherein the separating body is mounted in a housing which is provided with a medium inlet and medium outlet, optionally with a separate outlet for removing separated particle material.

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ROTATING PARTICLES SEPARATOR

The invention relates to a separating body which can be set into rotation for the purpose of separating solid or liquid particles of micron or sub-micron size from a gaseous or a liquid medium, wherein the relevant body consists of a large number of separating ducts with singly connected walls over a part of the axial length, characterized in that the length of at least one of the ducts designated with L, the hydraulic diameter of the duct designated with d and the average axial gas speed in the duct designated with w are chosen in mutual dependence in a manner such that the dimensionless number $Lv/(wd^2)$ equals a minimum of 0.035, preferably 0.040, wherein **v** is the kinematic viscosity of the medium. The invention also relates to a rotating particle separator which consists of the above described separating body, onto which impellers may or may not be fixed upstream and downstream and wherein the separating body is mounted in a housing which is provided with a medium inlet and medium outlet, optionally with a separate outlet for removing separated particle material.

EP 0286160, US 4,994,097 and US 5,073,177 relate to rotating particle separators with rotating axial separating ducts which are dimensioned such that the flow of the medium in the ducts is laminar in accordance with a Reynolds' number smaller than 2300. PCT/NL94/00079 relates to axial ducts placed non-parallel to the axis of rotation within defined limits such that secondary flows do not have an adverse effect on the separating process.

The new insight embodied in this invention is that the flow must not only be laminar and the ducts non-parallel up to certain limits but that the length/hydraulic diameter ratio of the ducts must at

least equal a specific value such that disturbances in the ducts are damped on entry into the duct and developed laminar viscous flow, in the case of circular ducts also known as Hagen-Poiseuille flow, has been adjusted in the ducts. Only when this condition has been met will a flow result wherein particles which enter the ducts with the gaseous or liquid medium are separated to the greatest possible extent. The minimum value of the length/diameter ratio of circular ducts wherein fully developed laminar viscous flow occurs in the ducts is given by the formula:

wherein w is the average medium speed in the duct, d the diameter of the duct, v the kinematic viscosity of the medium flowing through the ducts and a_1 a numeric value preferably equal to 0.035. In the case of non-circular ducts, developed laminar viscous flow is in any case ensured if d equals the hydraulic diameter of the duct given by the formula:

$$d = 4A/S$$

wherein A is the surface area of the duct over which flow occurs and S the length of the curve enclosing the surface area.

The above requirement is of particular importance because in practical embodiments of rotating separating ducts the flow is subjected at entry to disturbances, including vortices, which will disrupt the process of separating particles. As the distance from entry into the duct increases, boundary layers on the walls of the ducts will increase in thickness. At a distance wherein the length/hydraulic diameter ratio corresponds with the minimum value as specified above, the boundary layers fill the whole duct. A fully developed laminar viscous flow has been adjusted. Disturbances in the flow are for the greater part damped down and the radially directed separation of particles induced by centrifugal forces can continue virtually undisturbed.

In practical embodiments axial medium speeds of 1 to 5 m/s may possibly occur, while the hydraulic diameter of the ducts may possibly have values of 1 or 3 mm. If we take the case of separating particles from air, then the kinematic viscosity amounts to 1.5 x $10^{-5}m^2/s$. The minimum required length/hydraulic diameter ratio varies for the above mentioned example from 2.3 to 35. At a hydraulic diameter of 1 mm with an axial air speed of 1 m/s, L/d must be a minimum of 2.3, at a hydraulic diameter of 3 mm and an air speed of 5 m/s, L/d must be a minimum of 35 in order to realize a flow wherein a very high degree of separation is possible. If this requirement is not met separation percentages will be found which are considerably smaller than substantially full separation.

It is of further importance that the flow in the ducts remains stable and does not for instance turn into one or other form of turbulence or is subject to other time-dependent fluctuations. For non-rotating ducts this requirement will be met if the Reynolds' number based on the axial flow speed of the medium is limited to a certain value. This value depends on the form of the ducts and will in practice lie round a numerical value of about 2000 if the Reynolds' number is based on average axial gas speed and hydraulic diameter of the ducts. A complication may occur if the ducts rotate as in the case of the present invention. According to recent insights into flows, stability of the flow can only be guaranteed in the case of rotation if, in addition to the Reynolds' number based on axial duct speed, the Reynolds' number based on the angular speed of the ducts is also limited to a certain value. For the dimensions and physical data of practical embodiments of the present invention this requirement is met as the occasion arises if the ducts are bounded by singly connected walls. Destabilization due to rotation is hereby prevented and limiting of the Reynolds' number based on the axial gas speed to a value known for non-rotating ducts is sufficient in such cases to effect stable developed laminar viscous flow, provided

the length/hydraulic diameter ratio is at least equal to the required value according to the invention. Radially directed separation of particles is controlled by centrifugal forces and Stokes' forces. Important parameters in the process of radially directed separation of particles are: dynamic viscosity as opposed to kinematic viscosity, and radial distance between the walls of the ducts as opposed to hydraulic diameter. The density of the medium is of secondary importance for the radial separation process of particles as long as the density of the medium is much smaller than the density of the particles for separating. In accordance with the phenomenon forming the basis of the present invention, in the case of gaseous media the density of the gaseous medium has a direct influence via the kinematic viscosity which is related to the dynamic viscosity via the density of the gaseous medium.

The separating ducts can be manufactured in diverse ways. The possibility exists of making these walls of a material or applying a layer to the walls such that a catalytic action or other type of physical or chemical action occurs. This catalytic, physical or chemical action can be aimed at bringing about a determined chemical reaction or physical conversion: for instance the catalytic conversion of nitrogen oxides or the absorption of moisture, evaporation of liquid or the dissolving of aerosols of for instance tar. Intended physical/chemical/thermodynamic conversions can then also take place in addition to the separation of particles. Such a conversion can generally be realized to a sufficient extent if the length/hydraulic diameter ratio has a value at least equal to that according to the present invention. The reason for this is that in such cases the diffusion coefficient is of a magnitude comparable to the kinematic viscosity, so that at the minimal length/hydraulic diameter ratio according to the invention the dimensionless number $LD/(wd^2)$, wherein D is the

diffusion coefficient, is sufficiently large to cause the intended physical and/or chemical action to take place.

During the separation of particles a part of the walls on which these particles come to rest can be shielded from the gas. The remaining wall surface is however sufficient to cause the intended physical/chemical/thermodynamic action to take place therefrom. The present invention is therefore highly suitable for purifying gases of undesired particles and effecting specific chemical/physical/thermodynamic conversions in one device.

The present invention is also suitable for causing physical/chemical/thermodynamic conversions to take place by intentionally injecting additives, for instance in the form of small particles, into the gas before entry into the ducts. These additives may for instance result in a catalytic action, can remove gaseous components such as chlorine compounds and sulphur compounds from the gas or can absorb for instance moisture. Small particles in the form of minute liquid droplets can also be injected with which a wet washing is also achieved. The additives or particles can evaporate partially whereby the gas is cooled. The intended action of particles and droplets occurs during residence in the gas as well as during the period when particles and droplets are flung out and are situated on the catch walls of the separating duct. The intended action is obtained if the length/hydraulic diameter ratio of the ducts is at least equal to required value according to the invention.

The invention therefore relates to a separating body which can be set into rotation for the purpose of separating solid or liquid particles of micron or sub-micron size from a medium, wherein the relevant body consists of a large number of separating ducts with singly connected walls over a part of the axial length, characterized in that the length of at least one of the ducts designated with L, the hydraulic diameter of the duct designated with d and the average axial medium speed in the duct

designated with w are chosen in mutual dependence in a manner such that the dimensionless number $Lv/(wd^2)$ equals a minimum of a_1, wherein v is the kinematic viscosity of the medium and a_1 equals 0.030, preferably 0.035.

The invention also relates to a separating body with ducts wherein at least one duct has a wall where provisions are arranged to cause a catalytic or chemical or physical or thermodynamic conversion to take place.

In the separating body the number of ducts is generally larger than 100, such as 150 to 1,000,000. The number of ducts with the intended minimum value of the dimensionless number is generally more than 20 to 30%. In preference practically all ducts have the intended minimum value of the dimensionless number. If in addition to particle separation physical and/or chemical action is also effected in the ducts and if the diffusion coefficient designated with D differs in magnitude from the kinematic viscosity designated with v, a minimum of one of the ducts where the physical and/or chemical action is effected then has to be chosen such that the dimensionless number $LD/(wd^2)$ equals at least 0.035 and, as the occasion arises, equals at least 0.1.

In preference the separating body is provided with a spray unit for removal from a separating duct of particles separated therein with spray medium through the duct, so that during operation or non-operation separated particulate material can be removed rapidly and efficiently via and from each separating duct.

If in further preference the separating body is provided with medium inlet and/or medium outlet means such that the centrifugal pressure increase is equal to or greater than the pressure fall over the separating body, short-circuit flows are avoided and sealing means can optionally be dispensed with. The medium inlet and/or medium outlet means can be embodied such that the medium flow is maintained without the necessity of an additional provision such as a fan.

The present invention further relates to a separating unit provided with at least two separating bodies.

The invention also relates to a separating body according to the invention wherein static filters are placed downstream and/or upstream.

The invention also relates to a separating body which can be set into rotation to separate solid or liquid particles of micron or sub-micron size from a medium, wherein said body consists of a large number of separating ducts with singly connected walls over a substantial part of the axial length, which is characterized in that it is provided with a spray unit for removal from a separating duct of particles separated therein with spray medium through the duct.

The invention also relates to a separating body which can be set into rotation to separate solid or liquid particles of micron or sub-micron size from a medium, wherein said body consists of a large number of separating ducts with singly connected walls over a substantial part of the axial length, which is characterized in that the separating body is rotatably drivable with a motor which is fixed flexibly to a frame.

The invention also relates to a separating body which can be set into rotation to separate solid or liquid particles of micron or sub-micron size from a medium, wherein said body consists of a large number of separating ducts with singly connected walls over a substantial part of the axial length, which is characterized in that it is provided with medium inlet and/or medium outlet means such that the centrifugal pressure increase is equal to or greater than the pressure fall over the separating body.

In an embodiment of the separating body according to the invention the separating ducts consist of corrugated material wrapped round a shaft or pipe. The material can consist of paper, cardboard, foil, metal, plastic or ceramic.

In a further embodiment of the separating body according to the invention the separating ducts are formed by ducts in a perforated or otherwise axially porous body.

In a further embodiment of the separating body according to the invention the separating ducts are formed by concentric cylinders, wherein the space between the cylinders is intersected by a tangential wall.

In yet another embodiment of the separating body according to the invention the hydraulic diameter of at least one separating duct and the average through-flow speed of the medium in the separating duct are chosen in mutual dependence in a manner such that the Reynolds' number is smaller than 2300, and preferably smaller than 2000, thereby ensuring a laminar flow in the separating duct.

In a further embodiment of the separating body according to the invention the ducts are non-parallel to the axis of rotation. In order to prevent the disruptive effect of secondary flows generated by Coriolis forces the degree of non-parallelism is preferably bounded. A minimum of one of the ducts is preferably chosen such that the tangent of the angle between the tangent planes to the walls of the separating duct and the axis of rotation designated with tan α, the height of the duct designated with h, the length of the duct designated with L and the rotation speed of the duct designated with Ω are in mutual dependence such that the dimensionless number $(\Omega \, Lh \tan \alpha)/\mathbf{v}$ is smaller over a substantial part of the separating duct than 640, wherein $\mathbf{v}$ is the kinematic viscosity of the medium.

In yet another embodiment of the separating body according to the invention means are provided which include impellers which result in centrifugal pressure increase and maintain the gas or liquid flow, static provisions are arranged in the outlet which effect a physical or chemical or thermodynamic process: for instance an absolute filter which removes all residual

emissions of particles or a heating or cooling element. Such a provision will generally cause a pressure fall. By placing this provision directly in the outlet behind the means which provides centrifugal pressure increase and maintains the flow, a more effective conversion of speeds into pressures can be realized. At least a part of the pressure fall caused by the provision is thus produced by decreasing the losses during conversion of speed pressure into static pressure. The final pressure loss is therefore less than the sum of the individual pressure losses as a consequence of the conversion of speed into pressure and the static pressure fall over the provision. The combination of a rotating filter according to the invention and a static provision downstream thus offers attractive advantages. The rotating filter ensures that downstream the gas is purified of undesired particles. The static provision placed behind the means maintaining the flow, including an impeller, ensures a lower pressure fall and a lower energy consumption.

Shown in Fig. 1 are schematic drawings of a longitudinal section and a cross section of a particle separator provided with a separating body with separating ducts according to the invention. Situated upstream and downstream of the separating ducts are gas guiding means, for instance impellers 1 and 2 provided with blades 3 which may or may not be curved. Gas guiding means and separating ducts are mounted on a shaft which is driven by motor 4.

The gas 5 for cleaning enters the housing axially on the underside and is set into rotation by means of inlet impeller 1 and guided into the rotating separating ducts 6. Due to centrifugal action liquid particles and solid particles separate from the gas and deposit on the outer walls of the separating ducts. The gas with particles removed leaves the ducts via outlet impeller 2 and is carried via volute housing 7 provided with double outlet 8 to a further unspecified collection space or plenum. The particle material collected in the separating ducts

can be removed by taking the separating body out of the housing and subsequently cleaning or replacing it with a new body. The separating body can also be cleaned in situ, for instance by applying vibrations, by generating sound waves or, preferably, by spraying through the ducts with air or other gaseous or a liquid medium under pressure.

Possible leakage flows of cleaned gas at the outlet to uncleaned gas at the entry or vice versa can be prevented by a suitably chosen pressure distribution in the particle separator. As a consequence of centrifugal action gas flowing through impeller 1 and 2 in radial sense will undergo an increase in pressure. If this pressure increase is equal to the pressure fall due to resistance the gas encounters when flowing through separating ducts 6, the pressure at the outlet will be the same as that at the entry and no leakage flows will occur via the intermediate space. If the rotating particle separator is designed such that the centrifugal pressure increase of the gas is slightly greater than the pressure fall over the ducts, only a small back-flow of cleaned gas to uncleaned gas will take place. Special or high-grade seals are not then necessary. Characteristic for such an embodiment is that the separating body and the gas guiding means are constructed such that the cleaned gas exits at a radius which is greater than the radius at which the gas for cleaning enters.

An example of another possible embodiment of the rotating particle separator provided with a separating body according to the invention is shown in Fig. 2. Characteristic for this embodiment is a tangential inlet 10 which is placed upstream of the rotating separating body 11 which is provided with sealing impeller 12 and is fixed to the housing by means of bearing 13. The gas for cleaning flows tangentially into the cyclone-like inlet housing 14. As a result of centrifugal action due to the rotating movement of the gas in the inlet housing, the coarser particles in the gas will be flung outward and

leave the inlet housing via funnel 15. The finer particles will subsequently be separated in the separating ducts of the separating body. The gas with the particles removed leaves the rotating particle separator via impeller 12 and the volute outlet housing 16. Created between outlet housing 16 and inlet housing 14 by means of sealing impeller 12 is a radial back pressure which ensures that no undesired flow of unfiltered medium takes place from the inlet housing, where a higher pressure prevails, to the outlet housing where, as a result of pressure fall over the separating body, a lower pressure prevails.

The particle material collected in the ducts can be removed periodically using a spray unit 17 which is horizontally displaceable 18 over the ducts and which sprays air or another gaseous or a liquid medium 19 through the ducts in upstream direction. Collected particle material is then moved to inlet housing 14 and leaves the rotating particle separator via funnel 15. This process can take place both during standstill and during rotational operation. In the latter case the particle material blown out of the rotating separating body will be flung into the cyclone-like inlet housing 14 and, as in the pre-separation of coarser particles, there leave the inlet housing via funnel 15. By causing the blowing in upstream direction to take place in dosed and directed manner the separating process of the rotating particle separator is only disrupted to a small extent and regeneration of the rotating particle separator can take place without it having to be rendered inoperative and the separating process interrupted. As the occasion arises, the rotating separating body can be set into desired rotation as in the operation of a turbine by suitable dimensioning of inter alia inlet 10. The energy required for the driving derives from the pressure fall created in the medium flowing from inlet to outlet. External driving by means of a motor or pulley 20 is not required, or only to a slight extent.

Where required, bearing 13 is attached to the housing flexibly by means of springs and/or dampers. This achieves that imbalancing forces, which act on bearings and housing during rotation, are minimal.

The example of an embodiment of the rotating particle separator shown in Fig. 2 is particularly suitable for filtering gases from industrial processes with high concentrations of particle material, for instance gases from coal and waste burning plants, where concentrations of 10 to 100 gram/m^3 are not unusual. A significant part of the particle material often consists in such processes of coarser particles with diameters of about 10 micron and larger. This material is separated in the cyclone-like inlet space, whereby the concentration of particle material delivered to the rotating separating body according to the invention becomes markedly lower, for instance 1 gram/m^3. The time within which the ducts could become blocked can thereby be considerably extended, for example to more than an hour. Within this time compass the spray unit 17, such as an air jet, is set into operation in order to clear the separating body of particle material in good time and to allow the separating process to continue uninterrupted.

Concentrations of particle material in outside air are markedly lower than those usual in industrial process gases. The concentrations of particle material in outside air are generally lower than 1 milligram/m^3. When the rotating particle separator according to the invention is used for the purpose of air filtering the separating body will only become saturated after a long period of use which can amount to more than a year. In situ cleaning is then less necessary and the embodiment with axial inlet as shown in Fig. 1 is appropriate for such an application.

The rotating particle separator with separating ducts according to the invention is suitable for separating both solid and liquid particles from gases. After being flung out into the separating ducts liquid parti-

cles will form a liquid film on the radial walls of the separating ducts. As a result of the force of gravity the liquid film will move downward when the walls of the separating ducts are placed vertically. The liquid leaves the ducts on the underside where, as a result of the centrifugal force, the liquid is thrown out in the form of droplets. These droplets can be drained by means of suitable provisions. For example, in the case of the embodiment as shown in Fig. 2, the droplets will fall into the cyclone-like inlet space and leave the rotating particle separator via the funnel. In the case of the embodiment shown in Fig. 1, the droplets can leave the rotating particle separator through holes 9 arranged in the radial walls of the inlet impeller.

The liquid film occurring on the walls of the separating ducts in the case of liquid particle material will then only move downward when the liquid is subjected to a downward force. In the case the ducts are in inclining position a situation can occur wherein the downward oriented force of gravity is neutralized by the component of the centrifugal force which occurs in the lengthwise direction of the duct in the case of an inclining position. Such a situation can be prevented by limiting the inclination of the ducts to an angle whose tangent is smaller than the ratio of gravitational and centrifugal force.

The rotating particle separator according to the invention can be a component of a chemical or physical process. This can be effected by making the walls of the ducts from a suitable material. Fine particles can also be dispersed in the gas at or prior to entry into the cyclone-like inlet housing or by means of the spray unit 17 and can thus bring about a chemical or physical conversion of the gas or the liquid or parts of the gas or the liquid by absorption, desorption, adsorption, chemical reaction or catalytic reaction. The fine particles are separated in the rotating element. An effective rotating reactor is thus created. The fact that opera-

tions can be performed here with extremely small particles offers interesting perspectives relative to existing reactors. The comparatively large contact surface between the gas phase and the solid phase enables short reaction and capture times. This results in a small reactor volume, or a compact structure.

The rotating particle separator according to the invention can also be used for separating condensable gaseous components which are present in a gas; for example, drying of gases. Setting the gas into rotation for entry into the separating ducts of the separating body according to the invention can take place such that cooling occurs for instance due to expansion, and vapourform components in the gas condense to mist droplets. These droplets are separated in the separating ducts, whereafter the dried gas leaves the rotating particle separator via the outlet impeller where the dried gas is brought to the desired pressure and temperature. Using the rotating particle separator a thermodynamic process is thus brought about wherein a gas in vapour form is fractionated into a drier gas and condensate of lower temperature. Such a process can be applied inter alia as alternative to existing energy conversion systems including cooling systems based on freon, heating devices and heat pumps.

The rotating particle separator according to the invention is also suitable for use in conditions wherein the gas is under high pressure. In such applications the housing of the rotating particle separator can be constructed such that it is pressure-resistant, or the rotating particle separator as a whole can be placed in a separate pressure vessel. Possible sealing problems at the lead-through of the drive shaft of the rotating particle separator can be solved by also displacing the drive inside the pressure vessel. In this manner very high pressures can be permitted of up to 400 bar. High temperatures can also be permitted through suitable choice of material and by arranging cooling devices. With

the use of high-grade metal alloys gas temperatures of up to about 800°C can be permitted. If the internal components of the rotating particle separator according to the invention are made of ceramic, temperatures of up to as high as 1600°C can be permitted.

The particle separators shown in Fig. 1 and Fig. 2 are only examples of possible embodiments of particle separators provided with separating body according to the invention. Subject to the type of application many other embodiments are possible. Characteristic herein is that the particle separators are provided with a separating body according to the invention, that impellers may or may not be arranged upstream and downstream of the separating body and that the separating body may or may not be placed in a housing provided with gas inlet and gas outlet and optionally a separate outlet for removing separated particle material.

In the filtering of large quantities of gas there is the possibility of placing in parallel a plurality of rotating particle separators according to the invention. The gas flow for filtering is divided over the different rotating particle separators for subsequent collection, after filtering, in a collective discharge conduit. Since each rotating particle separator can be designed such that the pressure in the gas outlet is at least equal to the gas pressure in the inlet, each rotating particle separator pumps its own gas flow. If a rotating particle separator comes to a desired or undesired standstill in such an arrangement of rotating particle separators placed in parallel, the gas flow through the rotating particle separator that has come to a standstill will also stop. The arranging of valves in the feed and/or discharge conduits of the rotating particle separators, in order for instance to isolate a rotating particle separator that has come to a standstill from the other operating rotating particle separators, is not necessary. Scaling up to installations of large numbers of rotating particle separators according to the invention placed in

parallel can thus take place in comparatively simple manner, wherein in order to reduce costs optional use can be made of a collective housing. This results in an installation whose filtering capacity is relatively unaffected by possible breakdown of a single unit.

The rotating particle separator according to the invention offers the possibility of removing solid and liquid particles of micron and sub-micron size from small and large quantities of hot or cold gas flows under high or low pressure in an exceptionally efficient and economic manner. Experiments performed with a series of prototypes of diverse dimensions produced excellent and consistent separating performances with low energy consumption and in variable process conditions. The crucial factor here was that the ducts of the separating body were dimensioned according to the invention.

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CLAIMS

1. Separating body which can be set into rotation to separate solid or liquid particles of micron or sub-micron size from a medium, wherein said body consists of a large number of separating ducts with singly connected walls over a part of the axial length, **characterized in that** the length of at least one of the ducts designated with L, the hydraulic diameter of the duct designated with d and the average axial gas speed in the duct designated with w are chosen in mutual dependence in a manner such that the dimensionless number $Lv/(wd^2)$ equals at least 0.035, wherein **v** is the kinematic viscosity of the medium.

2. Separating body as claimed in claim 1, wherein the dimensionless number equals at least 0.040.

3. Separating body as claimed in claims 1 and 2, wherein at least one duct has a wall which is provided with provisions for causing a physical and/or chemical process to take place.

4. Separating body as claimed in claim 1, 2 or 3, provided with a spray unit for removal from a separating duct of particles separated therein with spray medium through the duct.

5. Separating body as claimed in claim 4, wherein the spray unit is displaceable over and positionable above each separating duct.

6. Separating body as claimed in claims 1-5, wherein the separating body is rotatably drivable with a motor which is fixed flexibly to a frame.

7. Separating body as claimed in claims 1-6, provided with medium inlet and/or medium outlet means such that the centrifugal pressure increase is equal to or greater than the pressure fall over the separating body.

8. Separating body as claimed in claims 1-7, wherein the separating ducts are formed by corrugated material wrapped round a shaft or pipe.

9. Separating body as claimed in claims 1-7, wherein the separating body is formed by a perforated or porous body.

10. Separating body as claimed in claims 1-7, wherein the separating ducts are formed by concentric cylinders wherein the annulus is intersected by a tangential wall.

11. Separating body as claimed in claims 1-10, wherein the separating body is placed in a housing which is provided with a medium inlet and a medium outlet and optionally a particle outlet.

12. Separating body as claimed in claims 1-11, wherein a static provision is placed downstream to cause a chemical, physical or thermodynamic process to proceed.

13. Separating unit provided with at least two separating bodies as claimed in claims 1-12.

14. Separating unit as claimed in claims 1-13, wherein additives are added to the medium to cause a chemical, physical or thermodynamic process to proceed.

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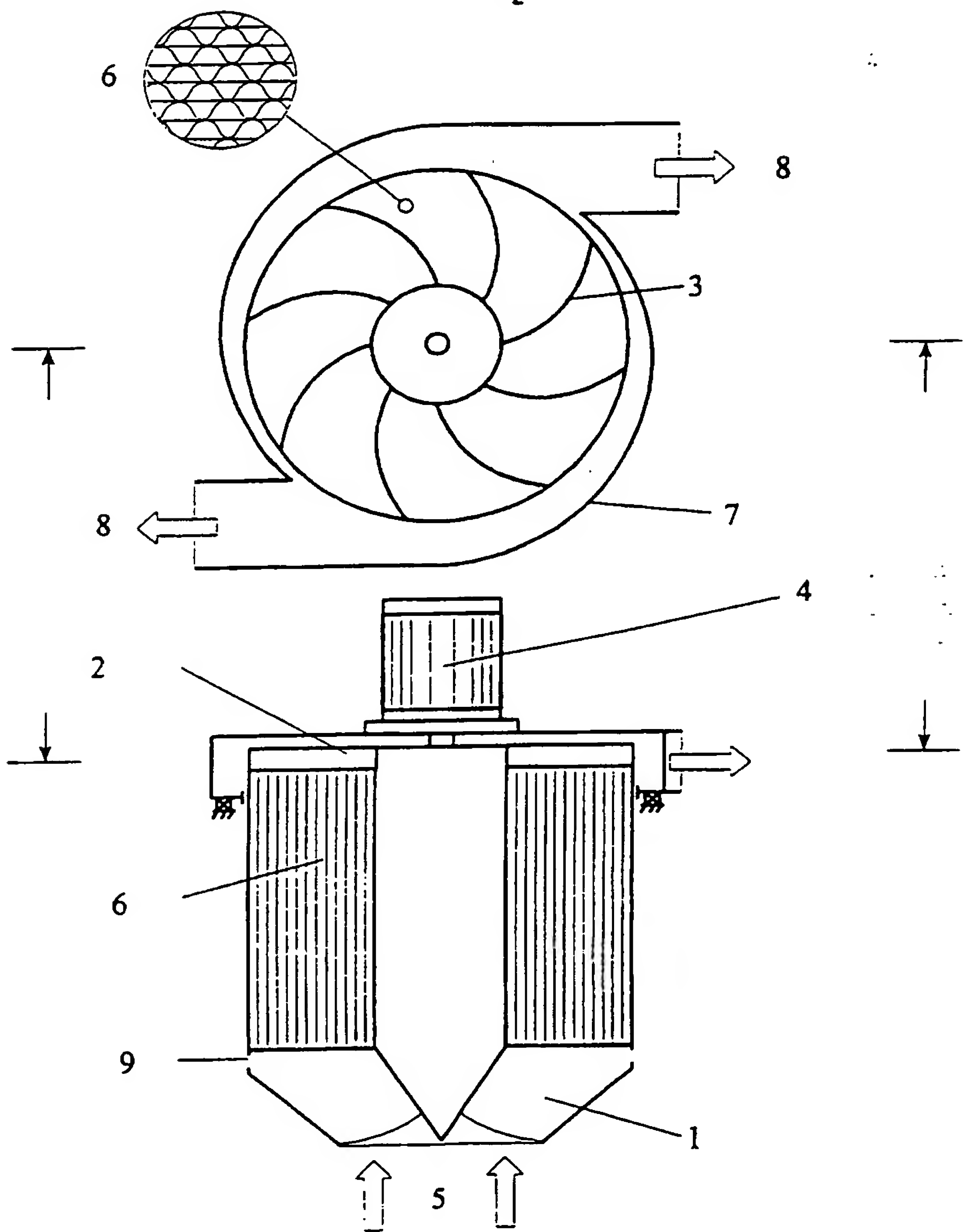
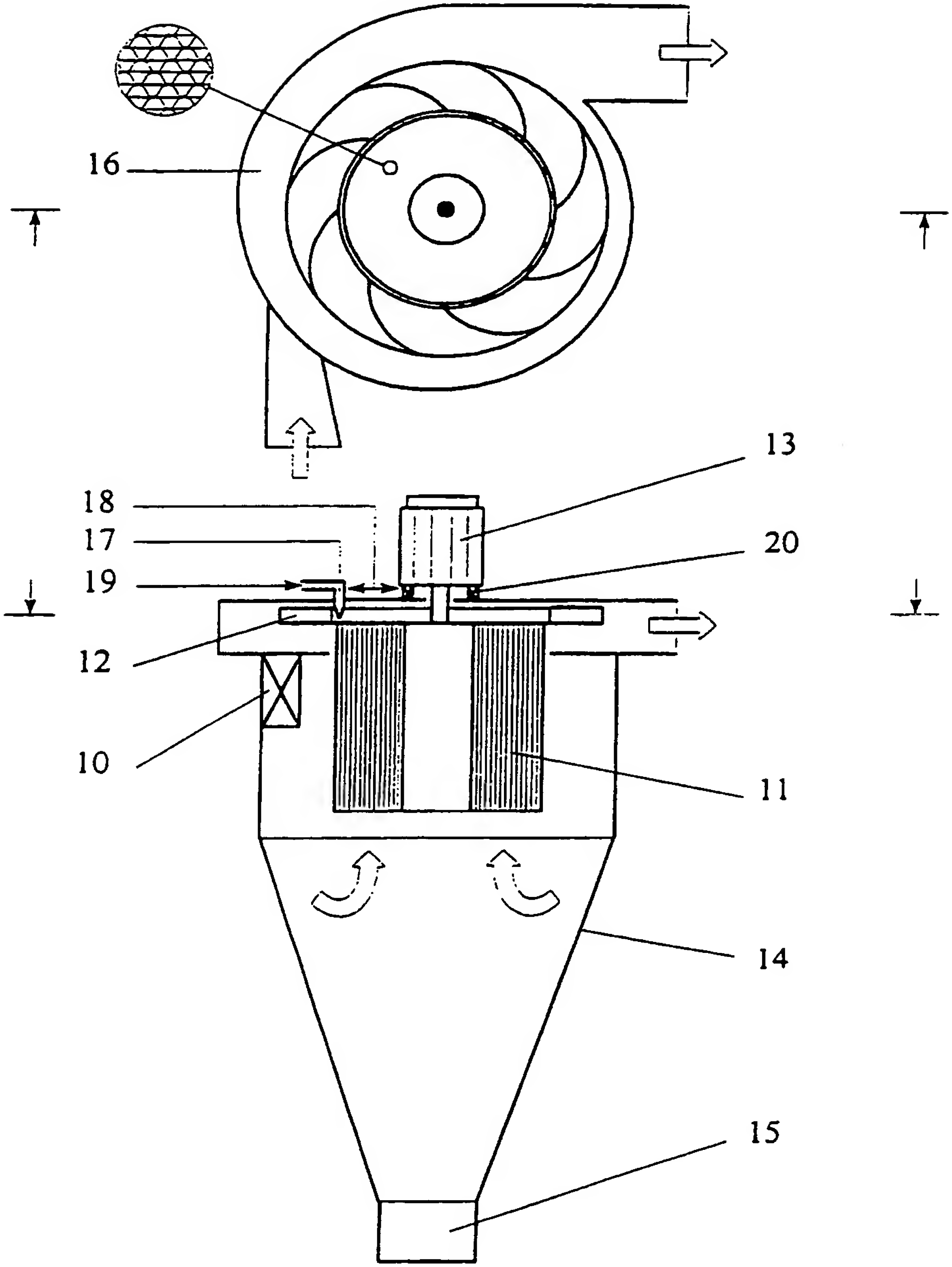


Figuur 1



Figuur 2

INTERNATIONAL SEARCH REPORT

International Application No
PCT/NL 97/00272

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B01D45/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 94 23823 A (ROMICO HOLD A V V ;BROUWERS JOZEF JOHANNES HUBERT (NL)) 27 October 1994 see the whole document ---	1-14
A	WO 95 17239 A (PHILIPS ELECTRONICS NV ;PHILIPS NORDEN AB (SE); PHILIPS ELECTRONIC) 29 June 1995 see claims 1-9; figures 1-8 ---	1-14
A	EP 0 532 105 A (PHILIPS NV) 17 March 1993 see the whole document ---	1-14
A	EP 0 286 160 A (BB ROMICO B V I O) 12 October 1988 cited in the application see the whole document --- -/--	1-14

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
"&" document member of the same patent family

1

Date of the actual completion of the international search	Date of mailing of the international search report
31 July 1997	13.08.97

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+ 31-70) 340-3016	Eijkenboom, A

INTERNATIONAL SEARCH REPORT

International Application No
PCT/NL 97/00272

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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International Application No
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/NL 97/00272

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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